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WATER SOLUBLE CONTACT LENS BLOCKING COMPOSITION

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Field of the Invention

The compositions of the invention can be used as a contact lens blocking compound in which a lens blank, button or disk is mounted into a cutting or shaping machine with the blocking compound for the purpose of machine shaping into a contact lens. The blocking compound of the invention is a water-soluble thermoplastic material that is convenient to apply, maintains an adequate mechanical positioning of the contact lens button, blank or disk for machining purposes but is readily removed with simple aqueous cleaning solutions, or simply hot water, once the lens is fully shaped. The invention relates to a composition and methods of using the composition.

Background of the Invention

Both hard and soft contact lenses are typically manufactured by obtaining a contact lens blank, button or disk (hereinafter "blank"). The plastic lens blank is made 5 by polymerizing a monomer mixture. The blank is machined into an optical shape providing a fixed correction (front curve and base curve) for the user's eye. The contact lens blank is shaped into the optical form by machining the blank. One common method is to use a cutting tool or lathe that removes sufficient material from either or both sides of the blank to give the plastic material the characteristic optical shape, a 10 front curve and base curve, relating to its degree and strength of correction. In order to shape the blank, the material must be connected to a lathe or other machine and then cut. The machining must be done carefully, since the tolerances relating to the correction require careful control of the ultimate dimensions. With this in mind, the blank must be held in its position in a very stable and predictable location. The most 15 common shaping method is to imbed the blank or button in a conventional "blocking wax" on a mandrel or other holder mechanism. The blocking compound holds the blank in a fixed unmoving position with respect to the cutting edge and can aid in attaining a desired shape. In this way, both the front curve and the base curve can be cut with great accuracy and the correction of the lens can be set using the typically 20 computer controlled machining parameters. In typical contact lens manufacture, a mandrel is dipped into melt blocking wax and is then manually wiped free of excess material. The contact lens is then imbedded into the adhesive and then mounted on a jig on the shaping machine.

Conventional blocking waxes for holding a contact lens blank in position on a 25 lathe have been typically aqueous insoluble organic thermoplastic materials. These materials require non-aqueous solvent removal and cleaning once the lathing, machining or other shaping steps are completed. In such a cleaning method, the contact lens and at least some of its blocking compound, along with the mandrel, in certain instances, are immersed in organic solvent such as 1,1,1-trichloroethylene, chloroform, 30 cyclohexanone or other such organic solvent material. While the solvent adequately removes the material from the contact lens and mandrel, the resulting solution of

blocking wax in solvent is hazardous waste and employee contact with the solvent can be irritating or disagreeable to the user.

Somewhat more recently, water-soluble blocking "waxes" have been proposed. Bonafini, Jr. et al., U.S. Patent Publication No. 2003/0119944 A1 teach a blocking wax composition comprising a variety of water soluble polymer materials and from about 10 to 50 wt% of a discontinuous solid phase. The solid phase suggested by Bonafini, Jr. et al. includes aluminum oxide (Al_2O_3), calcium oxide (CaCO_3), titanium oxide (TiO_2), silicon oxide (SiO_2) and similar aqueous insoluble materials. The materials disclosed by Bonafini, Jr. et al., while water soluble, are based on polyethylene glycol polymers.

Such materials have super cooling characteristics and do not readily solidify at low temperatures passing through a super cooled liquid phase. This characteristic of PEG based materials make them unsuitable for contact lens manufacture due to the delay in solidification and the uncertainty in maintaining the contact lens in the appropriate position.

The material suggested by Example IV in Bunnelle et al. is a material having a melting point substantially greater than 170°F. Such high melting materials are difficult to be used by the operating personnel, since materials of that temperature are not easily dealt with when used in the manual techniques common in today's contact lens manufacturing procedure. Lower temperature melt materials are required for comfort and safety of operating technicians. Neither Bunnelle et al. or Bonafini, Jr. et al. suggest the use of a material that will rapidly solidify at relatively low temperatures and that will remain substantially liquid at modest elevated temperatures in the range of about 135-170°F promoting rapid and efficient mounting of contact lens in the blocking material and machining the material into a useful lens.

Bunnelle et al., U.S. Patent No. 5,459,184, teach a moisture actuated hot melt adhesive. In Bunnelle et al., at Column 9, Example IV, is a contact lens blocking or mounting composition comprising a base polymer, hydrophilic additives and a filler such as calcium carbonate. On the whole, Bunnelle et al. suggest a specific polyalkyleneimine polymer, additive materials that have some hydrophilicity combined with a plasticizer and an aqueous insoluble filler. Fillers discussed in the Bunnelle et al. application include calcium carbonate (CaCO_3), zinc oxide (ZnO), alumina (Al_2O_3 ,

clay, titanium dioxide (TiO_2), talc, carbon black (C^0) and other similar substantially aqueous insoluble filler materials.

Neither Bunnelle et al. nor Bonafini, Jr. et al. suggest the use of water soluble filler materials. The blocking materials suggested by Bunnelle et al. and Bonafini, Jr. et al. have some utility in contact lens manufacture, but appear to be slow in dissolving in warm water and tend to require substantial time for a fully cleaned contact lens to be obtained after immersion in either warm water or aqueous cleaning solutions. In particular, we have observed that, upon immersion of blocking compounds such as that shown in Bunnelle et al., the material slowly dissolves but remains mechanically intact even as the final materials are removed by the cleaning solution.

A substantial need exists for a blocking compound that can be used by contact lens technicians without discomfort caused by excess melt temperatures and using materials that rapidly solidify to maintain the contact lens in the right position. Further, the contact lens blocking compound can be easily removed by the action of water or other aqueous cleaning solutions in a rapid process. The ideal materials will, upon contact with water, absorb water, become mechanically compromised and quickly break apart and become rapidly removed from the surface of the lens materials.

Brief Description of the Invention

We have found a new useful contact lens blocking composition involving a blend of water soluble polymer materials, hydroxy compound and an inorganic filler that has a melting point compatible with manual handling of the melt blocking compound and contact lens materials. The blocking compound is solid at a temperature that ranges from about ambient up to about 130°F or less and acts as a mechanically stable, predictable blocking compound. We have also found that a small, but effective amount of a surfactant material, blended with the water soluble polymer and filler material enhances cleanability of the blocking compound from the contact lens material or from the mandrel or other tool used in contact lens manufacture.

We have also found that a blocking compound that can be made more easily removable from the formed contact lens and any associated tool by combining a highly soluble salt into a water soluble polymer material. We have found that the salt material,

particularly if selected with an appropriate small particle size, causes the blocking compound to rapidly absorb water into the interior of the blocking material structure, rapidly softens the blocking compound and causes the blocking compound to fail mechanically before it is fully solubilized. As a result, the softened, mechanically 5 unstable material can be readily removed from the contact lens by warm water, aqueous cleaning solutions. The material is readily removed when exposed to ultrasonic cleaning conditions. In particular, the ultrasonic cleaning conditions tend to enhance the break-up of the blocking compound containing the water soluble salt in such a rapid fashion that the contact lens material can be formed substantially free of blocking 10 compound in a very short period of time substantially before the blocking compound is fully solubilized.

The exceptionally easily removable blocking composition can comprise a water-soluble organic polymer material combined with a highly water soluble salt. In general, the water soluble salts we have found useful are sodium or potassium salts of strong 15 acids. A strong acid is one that has a pKa greater than 5, often greater than 2. Such acids can produce a pH less than 4 in a 0.1 N aqueous solution. For the purpose of this disclosure the term "highly soluble salt" refers a material having solubility greater than 1 gram in a liter of water.

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Detailed Discussion of the Invention

We have found formulations of the water soluble polymer disclosed in the invention, an appropriate amount an inorganic filler that can provide the thermal properties required in the manufacture of the contact lens adhesive providing comfort and safety to operators while obtaining a fixed and mechanically stable mounting of the 25 contact lens in the shaping machines. We have found formulations of the water-soluble polymer with an appropriate amount of hydroxy organic compound and inorganic filler that can provide the properties needed in the blocking composition. The compositions of the invention can contain the large variety of water-soluble polymers and inorganic filler, preferably a soluble salt material. In sharp contrast to the prior art materials, the 30 materials rapidly melt at elevated temperatures to produce a material that can easily be applied to the mandrels, but cool rapidly to form a solid mounting material that, once

contact lens manufacture is completed, can be readily removed using aqueous solutions, ultrasonic cleaning and other techniques.

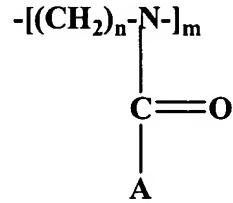
We have found that the combination of the water soluble polymer and the highly soluble salt provides a material that rapidly absorb water and become mechanically unstable, literally falling apart upon application of an aqueous cleaning solutions and particularly when exposed to ultrasonic cleaning conditions. We have found that a small, but effective, amount of surfactant material can enhance cleanability of the materials.

The contact lens blocking composition can comprise an aqueous soluble polymer material. A first aspect of the invention comprises a water-soluble polymer combined with a highly soluble sodium or potassium salt of a strong acid that can be used in a micronized form. A second aspect of the invention involves a water soluble polyethylene imine polymer with a soluble filler. A third aspect involves a water soluble polyethylene imine polymer combined with a hydroxy organic compound and inorganic filler formulated such that its melt properties provide a fluid polymer material at temperatures greater than about 160°F and a solid stable blocking compound at temperatures less than 130°F. Since the operating personnel often come into direct contact with melt adhesive, it is useful to have a material with a melting point and substantial fluidity at a temperature of less than 180°F, commonly less than 170°F or 160°F. Since the material must harden to hold the contact lens in a proper orientation, the material should have a melting point such that the material is substantially solid and mechanically stable at less than 130°F. For the purpose of this application, we believe the material should have a Brookfield viscosity of less than 500,000 cps, preferably less than 300,000 cP at 140°F, using spindle No. 29 in a thermosel viscometer, to meet these criteria including solidity at less than 130°F. If the material is not sufficiently fluid at 170°F, operating personnel can be made very uncomfortable in wiping excess adhesive if the melt temperature is substantially greater than 170°F and at more elevated temperatures, can result in skin damage and other hazards.

The blocking compositions of the invention contains an aqueous soluble polymer. Aqueous or water soluble polymer molecules or macro molecules that exhibit solubility in aqueous solutions represent a diverse class of polymers ranging from

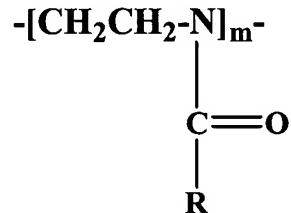
biopolymers to entirely synthetic resins. Water-soluble polymers that can be used in the compositions of the invention can include biopolymers, biopolymers containing synthetic groups, synthetic polymers in the form of nonionic, ionic, and other synthetic polymeric materials. The solution properties and solubility performance the water-
5 soluble polymers are dictated by structural characteristics of the polymer chain and the interaction between the polymer chain and water in the solvating reaction. The polymer structure may derive from a single monomer such as polyethylene oxide or acrylic monomers or from mixtures of monomers. The polymers can take the form of random, alternating, or grafted copolymer structures. The secondary structure of water-soluble
10 polymers is related to configuration intermolecular effects such as hydrogen bonding or ionic interactions. Tertiary structures involved in intermolecular and water -- polymer interactions. Functional groups obtaining aqueous solubility in a polymer typically contain at least one functional group selected from amine groups, hydroxyl groups, sulfhydryl groups, carboxylic groups, sulfonic groups, phosphonic groups and other
15 functional groups that can either be solvated by water or can react with water, or with a solvated reagent. Naturally occurring water-soluble polymers are typically polysaccharides or polysaccharide derivatives. Nonionic and anionic polymers useful in manufacturing the compositions of the invention include polyacrylamide, polyacrylic, polyacrylic acid, polymers and copolymers, etc., polyvinyl alcohol
20 polymers in various states of hydrolysis, ranging from partially hydrolyzed to fully hydrolyzed and super hydrolyzed materials can be used. Poly(vinyl pyrrolidone) polymers can also be used. Ionic water soluble polymers include polyacrylic acid, poly(vinyl sulfonic) acid and the soluble salts thereof.

The preferred water-soluble polymer for use in the compositions of the invention comprises a water-soluble polyalkyleneimine polymer. Preferred polymers comprise a N-acyl substituted polyalkyleneimine (A PeOx or Aquazol polymer) correspond to the formula:



5 wherein A is $-\text{R}_3-(\text{OR}_2)_p-\text{OR}$, $-(\text{CH}_2)_q-\text{C}-\text{OR}$, $-(\text{CH}_2)_q-\text{O}-\text{C}-\text{R}$; or $-\text{R}$;
 m is 50-10000, n is about 2-6; p is about 0-3; q is about 1-15; R is a C_1-C_{15}
 substantially hydrocarbon radicals such as alkyl, alkyl substituted aryl, etc., including
 such groups as methyl, ethyl, isobutyl, pentyl, cyclohexyl, 2-ethyl-hexyl-dodecyl,
 naphthyl, tolyl, benzyl, chloromethyl, fluoroethyl, chlorophenyl and phenylethyl; and
 10 R_2 and R_3 are selected from the group consisting of divalent hydrocarbon and
 substituted hydrocarbon radicals such as alkylene and arylene. Specific examples of R_2
 and R_3 groups include methylene, ethylene, tetramethylene; ortho-, meta- and para-
 phenylene; tolylene ($\text{C}_6\text{H}_4\text{CH}_2-$), chloroethylene, fluoroethylene, and chlorophenylene.

15 The most preferred polymer comprises a polyethylene oxazoline polymer
 corresponding to the formula:



wherein R is defined hereinabove, m is about 50-10,000, preferably about 100-7500.
 20 Most preferably, the monomer making up the substituted polyalkyleneimine comprises
 a C_{1-5} alkyl substituted-2-oxazoline. In other words, in the formula n is about 2. The
 molecular weights of these polymers range from about 40,000 to 500,000 and greater.

The polymers available in low (100,000 or less), moderate (100,000 to 250,000) and high (greater than about 300,000) molecular weight. The most preferable polyoxazoline polymers of the invention, for reason of low cost and rapid solubility in the presence of the aqueous soluble salt, are polymers having the formula above wherein m is about 50-
5 8000, R is a C₁₋₁₂ alkyl group, preferably a C₁₋₅ alkyl, including a poly(2-ethyl-2-oxazoline; CAS Number 25806-17-1) with a low molecular weight and Kinematic Viscosity of less than 10 cSt.

The contact lens blocking compound of the invention can contain a highly soluble inorganic salt to help in promoting removal of the blocking compound from the finished lens after lathe shaping. The highly soluble salt has a solubility greater than 1 gram per liter. Typical salts comprise highly soluble salts of strong mineral acid. Such acids include HCl, sulfuric acid, nitric acid, trichloroacetic acid, and other acid having a pKa less than 6 or less than 3, often less than 2 in a solution about 0.1% at room temperature. Examples of suitable salts include sodium chloride, potassium chloride,
10 sodium nitrate, potassium nitrate, sodium sulfate, ammonium chloride, potassium sulfate, potassium hydrogen sulfate and other similar highly soluble salts. Salts that are in the form of highly divided particulate materials having a particle size less than 150 microns or less than 100 microns are particularly useful. Such results are referred to as "micronized" particulate materials. We have found that the highly soluble salts of the
15 invention promote rapid solution of the blocking compound substantially in excess of materials such as titanium dioxide, calcium carbonate, aluminum oxide, silica or other common polymeric fillers.
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The blocking compound of the invention comprises a major amount of the water soluble polymer material combined with a highly soluble inorganic salt. One useful salt
25 is common table salt (NaCl) having a particle size greater than about 280 microns. Preferred highly soluble salts include salts having a particle size less than about 150 microns typically between about 5 and 90 microns. These small particle size materials are characterized as "micronized" salts. The aqueous soluble blocking compositions of the invention contain a sufficient but effective amount of the micronized salt to permit
30 the aqueous cleaning fluid to rapidly penetrate the polymer mass, dissolve the salt and the polymer material in a rapid cleaning step.

Ultrafine, food grade sodium chloride is produced by micropulverizing vacuum granulated salt. Salt particles are jagged fragments of cubes, exhibiting an extremely high specific surface area and low bulk density. A small amount of ultrafine (8 microns) tricalcium phosphate is added to prevent caking, but the products do not readily free-flow and tend to be exceptionally dusty. The material can be ground to less than 200 mesh (75 microns) or to less than 325 mesh (45 microns).

Tricalcium phosphate is water insoluble at neutral pH, slightly soluble in acid solution. It has GRAS approval as an anti-caking agent and is exempt from label declaration on foods incorporating the salt as an incidental, non-functional additive under 21 C.F.R. 101.100(a)(3). A small amount (less than 3%) of this material has no impact in solubility of the salt or performance in the blocking compound.

Table 1
Salt Filler Chemical Analysis

	Typical	Range
¹ Sodium Chloride (%)	98.0	87.6 - 98.4
Calcium Sulfate (%)	0.2	0.05 - 0.55
² Other Salts (%)	0.04	0.02 - 0.07
Moisture (%)	-	<0.1
Copper (ppm)	0.1	<0.5
Iron (ppm) Free	0.3	<1.0
³ Complexed	4	4 - 6
Tricalcium Phosphate (%)	1.75	1.5 - 2.0

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¹ By difference of impurities and additives, moisture-free basis (ASTM)

² Na₂SO₄, CaCl₂, MgSO₄

³ Contributed by tricalcium phosphate

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Table 2
Analytical Content (per 100g)

Ash (g)	>99.9
Calcium (mg)	760
Chloride (g)	59.4
Iodine (ug)	<100
Magnesium (mg)	5
Potassium (mg)	3
Sodium (g)	38.5

Table 3
Salt Physical Properties

Grade	Microns	Bulk Density* (g/ml)	Mean Crystal Size (um)	Mean Surface Area (cm ² /g)
200 mesh	75	0.6 - 0.8	35	1,900
325 mesh	45	0.56 - 0.7	25	2,500

* Loose pour

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Table 4
Sieve Analysis

U.S. Mesh	Opening Microns*	Percent Retained**			
		E.F. 200		E.F. 200	
		Hutchinson	Rittman		
100	150	Tr	Tr	Tr	Tr
200	75	4	<10	Tr	<10
325	45	15	15-22	10	5-28
400	38	-	-	9	5-19
Pan	-	81	73-89	81	60-92
		E.F. 325			
		Typical	Range		
200	74	Tr	Tr		
325	44	2	<5		
400	37	4	1-9		
Pan	-	94	86-96		

10 * 25,400 microns (micrometers, um) per inch.
 ** On individual screens.

Certain formulations can also comprise an effective amount of an inorganic extender or filler, such as calcium carbonate, zinc oxide, alumina, clays, titanium dioxide, talc, carbon black and the like. For example, the adhesives formulated to be moisture-sensitive and or repulpable can comprise up to about 25 wt-% of a mineral extender which is preferably fatty acid ester coated to increase its organophilicity. One commercially-available filler of this type is the stearate-calcium carbonate compound (Omya, Inc., Proctor, Vt.). The filler material can also function to reduce (if desired) the pressure-sensitivity of the moisture-activated adhesives of the present invention.

The blocking composition of the invention can typically comprise up to 95% of the water soluble polymer composition combined with about 0.5 to about 40 wt% of the water soluble salt. One preferred composition of the invention comprises about 15 to 55 wt% of the polyalkyloxazoline polymer of the invention combined with a water soluble salt material. Lastly, the most preferred compositions of the invention comprise about 25 to 45 wt% of the polyethyloxazoline composition, about 30 to 50 wt% of a hydrophilic (hydroxyl substituted or amine substituted additive material) compound and about 15 to 35 wt% of a sodium or potassium salt of a strong acid. The salt is preferably in the form of a micronized salt having a particle size less than about 90 or 5 75 microns. The water soluble polymer of the material can be used in the form of a single polymer species, a blend of two or more polymers of similar composition differing in molecular weight or a blend of two or more polymers of differing types and molecular weights. The blocking composition of the invention can also contain a hydrophilic additive material. Typically, the hydrophilic additive materials are 10 hydroxyl (-OH), amine substituted (-NH₂) compounds that are at least mildly hydrophilic, if not fully water soluble. Such additive materials typically comprise common plasticizers or tackifying agents that can be combined with the polymer species of the invention to either extend the polymer, reduce viscosity, increase tack, increase the softness of the polymer, increase needle penetration properties or otherwise 15 make the resulting blocking composition more amenable to contact lens blank or button imbedding and lathing practices. The resulting polymer materials must have a workable viscosity, must resist heat induced decomposition or physical property change and when used in a fixed structure, remain mechanically stable during machining.

20 The hot melt adhesives of this invention can contain a hydroxy substituted organic compound. The hydroxy substituted organic compound can be used to provide a number of functions to the composition. First, the combination of the organic properties and the hydroxy group in the compound promotes the formation of uniform 25 homogenous single phase compositions. Further, the hydroxy substituted organic compounds tend to produce adhesives with a workable viscosity, a controlled rate of set 30 and heat resistance. Lastly, the blending of sufficient quantities of the hydroxy substituted organic compounds in the hot melt adhesives of this invention can

substantially reduce (if desired) the pressure-sensitive properties of the adhesive. The important aspects of the hydroxy substituted organic compound is that it contains one or more hydroxy groups attached to an essentially organic composition. The organic composition can be essentially aliphatic or aromatic. Many hydroxy substituted organic
5 compounds exist including alcohols, hydroxy substituted waxes, polyalkylene oxide polymers (such as Carbowax.) and many others.

Preferred hydroxy substituted organic compounds include: C₁₀₋₃₀ fatty alcohols, hydroxy substituted waxes, hydroxy substituted fats, hydroxy substituted fatty acids, hydroxy substituted fatty amides, diacetin, polyalkylene oxide polymers having a
10 molecular weight of less than about 2000, preferably about 1000, such as polyethylene oxide, polypropylene oxide and others. For compatibility purposes we have found that the hydroxyl number of the hydroxy substituted organic compound should be at least 160 or preferably between a 200 and 500, and that at a level of more than 20 wt % of a
15 160 hydroxyl member, hydroxywax, an effective amount, 5 to 10 wt %, of a C₈₋₂₀ fatty acid, preferably a C₈₋₂₀ saturated fatty acid can be used.

The hot melt adhesive compositions may also incorporate relatively small amounts of adjuvants such as UV absorbers, heat stabilizers, flavorings, release agents, additional antiblocking agents and antioxidants. Typical antioxidants include the Irganox. series (Ciba-Giegy) such as Irganox 1076, octadecyl-3,5-di-tert-butyl-4-
20 hydroxy hydrocinnamate and the distearyl pentaerythritol diphosphite (Weston. 619, Borg-Warner Chemicals). When present, such adjuvants will commonly make up less than 5% by weight of the present adhesives.

The blend of additive materials of the invention can result in a workable material with controlled or absent tack, acceptable viscosity at elevated temperature and ease of
25 cleaning when finished. Many hydroxy and amino substituted additive materials are available. Such hydroxy substituted additives include hydroxy substituted waxes, polyethylene oxide polymers, polypropylene oxide polymers, fatty alcohols, amine substituted waxes, hydroxy and amine substituted fats and fatty acids, hydroxy substituted fatty amides, polyethylene glycols, polypropylene glycols, and other
30 materials.

The blocking composition of the invention can also contain conventional surfactants, tackifying agents and plasticizers. Many tackifying agents such as natural or synthetic resin and natural or synthetic resin blends are available including materials from Silvachem Corp., Schenectady Chemical Corp., Reichhold Chemical Inc., and

5 Hercules Inc. These materials can be natural products including rosin acid, hydrogenated rosin acid, tall oil residues, polymerized olefins, alkyl resins, phenolic resins, terpene-phenol resins and others. Plasticizer materials typically are considered to be materials that increase flexibility, distendability, needle penetration or other softening aspects of the compositions of the invention. Plasticizers often lower

10 viscosity of the melt composition and elastic modulus of the room temperature solids. Conventional ester plasticizers such as esters of adipic acid, azelaic acid, benzoic acid and citric acid can be used. Further, epoxides, glycolic acid esters, isophthalic acid esters, maleic acid esters, phosphate plasticizers, phthalate plasticizers, polyester plasticizers and others can be used. Preferred water insoluble plasticizers are any of the

15 common benzoate or hydroxy benzoate materials. Such plasticizers include glycerol tribenzoate, glycerol diacetate, pentaerythritol benzoate, mixed benzoates, mixed phthalates and other plasticizers. Certain water soluble plasticizers can be helpful in the compositions such as liquid polyalkylene glycols, such as PEG materials having a molecular weight from about 200 to about 800. The contact lens blocking composition

20 of the invention often contains a characteristic dye to aid in insuring that the material is fully removed from the contact lens after cleaning. Typical dyes can be incorporated into the blocking composition. Further, the invention can contain a variety of typical additives or adjuvants such as heat stabilizers, release agents, antioxidants, anti-

blocking compounds and other such materials to aid in removing the contact lens from

25 the material during aqueous cleaning steps.

The surfactant or surfactant admixture of the present invention can be selected from polymer compatible water-soluble or water dispersible nonionic, or anionic surface-active agents; or mixtures of each or both types. Nonionic and anionic surfactants offer diverse and comprehensive commercial selection, low price; and, most

30 important, excellent detergative effect - meaning surface wetting. Surface - active or "wetting agents" function to increase the penetrant activity of the invention into the

bulk polymer. Nonionic surfactants useful in the invention are generally characterized by the presence of an organic hydrophobic group and an organic hydrophilic group and are typically produced by the condensation of an organic aliphatic, alkyl aromatic or polyoxyalkylene hydrophobic compound with a hydrophilic alkaline oxide moiety
5 which in common practice is ethylene oxide or a polyhydration product thereof, polyethylene glycol. Practically any hydrophobic compound having a hydroxyl, carboxyl, amino, or amido group with a reactive hydrogen atom can be condensed with ethylene oxide, or its polydration adducts, or its mixtures with alkoxylanes such as propylene oxide to form a nonionic surface-active agent. The length of the hydrophilic
10 polyoxyalkylene moiety that is condensed with any particular hydrophobic compound can be readily adjusted to yield a water dispersible or water soluble compound having the desired degree of balance between hydrophilic and hydrophobic properties.

Useful surfactants in the present invention include: Aerosol OT-B Block polyoxypropylene-polyoxyethylene polymeric compounds based upon propylene glycol, ethylene glycol, glycerol, trimethylolpropane, and ethylenediamine as the initiator reactive hydrogen compound. Examples of polymeric compounds made from a sequential propylation and ethoxylation of initiator are commercially available under the trade name PLURONIC® manufactured by BASF Corp. PLURONIC® compounds are difunctional (two reactive hydrogens) compounds formed by condensing ethylene oxide with a hydrophobic base formed by the addition of propylene oxide to two hydroxyl groups of propylene glycol. This hydrophobic portion of the molecule weighs from about 1,000 to about 4,000. Ethylene oxide is then added to sandwich this hydrophobe between hydrophilic groups, controlled by length to constitute from about 10% by weight to about 80% by weight of the final molecule. TETRONIC®
25 compounds are tetra-functional block copolymers derived from the sequential additional of propylene oxide and ethylene oxide to ethylenediamine. The molecular weight of the propylene oxide hydrotype ranges from about 500 to about 7,000; and, the hydrophile, ethylene oxide, is added to constitute from about 10% by weight to about 80% by weight of the molecule.

30 Also useful nonionic surfactants include the condensation products of one mole of alkyl phenol wherein the alkyl constituent, contains from about 8 to about 18 carbon

atoms with from about 3 to about 50 moles of ethylene oxide. The alkyl group can, for example, be represented by diisobutylene, di-amyl, polymerized propylene, isoctyl, nonyl, and di-nonyl. Examples of commercial compounds of this chemistry are available on the market under the trade name IGEPAL® manufactured by Rhone-
5 Poulenc and TRITON® manufactured by Union Carbide.

Likewise useful nonionic surfactants include condensation products of one mole of a saturated or unsaturated, straight or branched chain alcohol having from about 6 to about 24 carbon atoms with from about 3 to about 50 moles of ethylene oxide. The alcohol moiety can consist of mixtures of alcohols in the above delineated carbon range
10 or it can consist of an alcohol having a specific number of carbon atoms within this range. Examples of like commercial surfactant are available under the trade name NEODOL® manufactured by Shell Chemical Co. and ALFONIC® manufactured by Vista Chemical Co.

Condensation products of one mole of saturated or unsaturated, straight or
15 branched chain carboxylic acid having from about 8 to about 18 carbon atoms with from about 6 to about 50 moles of ethylene oxide. The acid moiety can consist of mixtures of acids in the above delineated carbon atoms range or it can consist of an acid having a specific number of carbon atoms within the range. Examples of commercial compounds of this chemistry are available on the market under the trade name
20 NOPALCOL® manufactured by Henkel Corporation and LIPOPEG® manufactured by Lipo Chemicals, Inc. In addition to ethoxylated carboxylic acids, commonly called polyethylene glycol esters, other alkanoic acid esters formed by reaction with glycerides, glycerin, and polyhydric (saccharide or sorbitan/sorbitol) alcohols have application in this invention. All of these ester moieties have one or more reactive
25 hydrogen sites on their molecule which can undergo further acylation or ethylene oxide (alkoxide) addition to control the hydrophilicity of these substances.

Other useful surfactants are nonionics made by adding ethylene oxide to ethylene glycol to provide a hydrophile of designated molecular weight; and, then adding propylene oxide to obtain hydrophobic blocks on the outside (ends) of the
30 molecule. The hydrophobic portion of the molecule weighs from about 1,000 to about 3,100 with the central hydrophile comprising 10% by weight to about 80% by weight of

the final molecule. These “reverse” PLURONIC®’s are manufactured by the BASF Corporation under the trade name PLURONIC® surfactants. Likewise, the TETRONIC® surfactants are produced by the BASF Corporation by the sequential addition of ethylene oxide and propylene oxide to ethylenediamine. The hydrophobic portion of the molecule weighs from about 2,100 to about 6,700 with the central hydrophile comprising 10% by weight to 80% by weight of the final molecule.

Tertiary water soluble amine oxide surfactants are selected from the coconut or tallow dimethyl amine oxides. Also useful in the present invention are surface active substances which are categorized as anionics because the charge on the hydrophobe is negative; or surfactants in which the hydrophobic section of the molecule carries no charge unless the pH is elevated to neutrality or above (e.g. carboxylic acids). Carboxylate, sulfonate, sulfate and phosphate are the polar (hydrophilic) solubilizing groups found in anionic surfactants. Of the cations (counterions) associated with these polar groups, sodium, lithium and potassium impart water solubility and are most preferred in compositions of the present invention. Examples of suitable synthetic, water soluble anionic compounds are the alkali metal (such as sodium, lithium and potassium) salts or the alkyl mononuclear aromatic sulfonates such as the alkyl benzene sulfonates containing from about 5 to about 18 carbon atoms in the alkyl group in a straight or branched chain, e.g., the salts of alkyl benzene sulfonates or of alkyl naphthalene sulfonate, dialkyl naphthalene sulfonate and alkoxylated derivatives. Other anionic detergents are the olefin sulfonates, including long chain alkene sulfonates, long chain hydroxyalkane sulfonates or mixtures of alkenesulfonates and hydroxyalkane-sulfonates and alkylpoly (ethyleneoxy) ether sulfonates. Also included are the alkyl sulfates, alkyl poly (ethyleneoxy) ether sulfates and aromatic poly (ethyleneoxy) sulfates such as the sulfates or condensation products of ethylene oxide and nonyl phenol (usually having 1 to 6 oxyethylene groups per molecule).

TABLE 5

Water Soluble Polymer Compositions

Component	Wt%		
Water soluble Polymer	5 - 95	10 - 70	20- 50
Hydroxy Comp.	up to 50	5 - 70	10 - 60
Filler	up to 50	1 - 50	2 - 40
Water Soluble Filler	up to 50	1 - 50	2 - 45
Surfactant	0	0.01 - 2.0	0.1 - 1
Plasticizer	0	0.1 - 10	0.2 - 5
Tackifier	0	0.1 - 10	0.2 - 5

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TABLE 6

Aquazol or PeOx Compositions

Component	Wt%		
Water soluble PeOx Polymer	10 - 75	10 - 70	20- 50
Hydroxy Comp.	up to 50	5 - 70	10 - 60
Filler	up to 50	1 - 50	2 - 40
Water Soluble Filler	0.1 - 50	1 - 50	2 - 45
Surfactant	0	0.01 - 2	0.1 - 1
Plasticizer	0	0.1 - 10	0.2 - 5
Tackifier	0	0.1 - 10	0.2 - 5

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The invention is exemplified by the following initial formulations that are made by heating with stirring, at elevated temperature of about 325°F, the steryl or cetyl alcohol, adding the Aquazol-50 polymer followed by the salt and then other components.

Example 1

INGREDIENT	PERCENT (%)
Polyethylene Oxazoline (Aquazol-50) 50,000 mw; 6.9 cSt K. Viscosity	35
Crodacol S95 (stearyl alcohol)	40
Micronized sodium chloride	25

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Example 2

INGREDIENT	PERCENT (%)
Polyethylene Oxazoline (Aquazol-50) 50,000 mw; 6.9 cSt K. Viscosity	35
Stearyl Alcohol	30
Foral WA tackifier	10
Micronized sodium chloride	25

Example 3

INGREDIENT	PERCENT (%)
Polyethylene Oxazoline (Aquazol-50) 50,000 mw; 6.9 cSt K. Viscosity	27
Cetyl Alcohol	35.3
Micronized sodium chloride	35.5
Aerosol OT-B	2
Irganox 1010	0.2

These formulations are substantially more soluble in water, are more easily removed from the finished contact lens and as a result improves productivity and processing of the contact lens materials.

The above specification, examples and data provide a complete description of
5 the manufacture and use of the composition of the invention. Since many embodiments of the invention can be made without departing from the spirit and scope of the invention, the invention resides in the claims hereinafter appended.